CLAIMS

I claim:

1. A MEMS device, comprising:

a first flexible beam coupled at a first end to a substrate and at a second end to a movable plate positioned at an offset distance from the substrate, said first and second ends separated by a prescribed distance at a rest position; and

one or more motion drives adapted to change the distance between the first and second ends from said prescribed distance, thereby changing the offset distance.

2. The device of claim 1, wherein:

the one or more motion drives have one or more movable portions supported on the substrate and mechanically coupled to the first flexible beam, said portions adapted to move substantially along a plane parallel to the substrate; and

the first flexible beam is adapted to transfer motion from the one or more movable portions to the movable plate such that the offset distance is changed.

3. The device of claim 1, wherein the prescribed distance corresponds to a loaded state of the first flexible beam.

4. The device of claim 1, wherein the device has a second flexible beam coupled to the substrate, the movable plate, and the one or more motion drives.

5. The device of claim 4, wherein the one or more motion drives are adapted to bend the flexible beams, wherein, when non-end sections of the first and second flexible beams move in opposite directions, the offset distance is changed.

6. The device of claim 5, wherein:

the one or more motion drives are adapted to move the non-end sections of the first and second flexible beams in the opposite directions by substantially equal distances; and

the movable plate is adapted to translate with respect to the substrate.

7. The device of claim 5, wherein:

a first motion drive is adapted to bend the first flexible beam;

a second motion drive is adapted to bend the second flexible beam;

bending of the first flexible beam and bending of the second flexible beam are substantially independent of each other; and

the movable plate is adapted to rotate with respect to the substrate.

8. The device of claim 5, wherein the one or more motion drives include a motion drive having (i) a first portion fixedly connected to the substrate and (ii) a second portion attached to the non-end section of the corresponding flexible beam, wherein, when a voltage differential is applied between the first and second portions, the second portion moves with respect to the substrate, thereby bending said flexible beam.

9. The device of claim 1, wherein the plate has a reflective surface.

10. The device of claim 1, comprising two or more spring structures, each spring structure having two flexible beams connected to the substrate, wherein:

the two spring structures are connected by a beam structure; and

the plate is mounted on the beam structure.

11. The device of claim 1, wherein the plate is a segment of a segmented plate.

12. The device of claim 11, wherein each segment is adapted to move substantially independent of every other segment.

13. The device of claim 1, wherein:

the plate comprises a deformable membrane; and

motion generated by the one or more motion drives deforms the membrane.

14. The device of claim 1, wherein the one or more motion drives include a motion drive having first and second movable portions, each adapted to move with respect to the substrate and the other movable portion.

15. A MEMS device, comprising:

a spring structure coupled between a substrate and a movable plate positioned at an offset

distance from the substrate; and

one or more motion drives having one or more movable portions supported on the substrate and mechanically coupled to the spring structure, wherein:

the one or more movable portions are adapted to move substantially along a plane parallel to the substrate; and

the spring structure is adapted to transfer motion of the one or more movable portions to the movable plate such that the offset distance is changed.

16. The device of claim 15, wherein:

the spring structure has one or more flexible beams, each coupled to at least two of: (i) the substrate, (ii) the movable plate, and (iii) one of the motion drives; and

the one or more motion drives are adapted to bend the one or more flexible beams to change the offset distance.

17. The device of claim 16, wherein the one or more motion drives include a motion drive having (i) a first portion fixedly connected to the substrate and (ii) a second portion attached to the corresponding flexible beam, wherein, when a voltage differential is applied between the first and second portions, the second portion moves with respect to the substrate, thereby bending said flexible beam.

18. The device of claim 16, wherein:

the one or more motion drives include a motion drive having first and second movable portions, each adapted to move with respect to the substrate and the other movable portion;

the first movable portion is attached to a first flexible beam; and

the second movable portion is attached to a second flexible beam, wherein, when a voltage differential is applied between the first and second portions, the first and second portions move with respect to the substrate and each other, thereby bending the first and second flexible beams.

19. The device of claim 15, wherein the one or more motion drives include a motion drive having first and second movable portions, each adapted to move with respect to the substrate and the other movable portion.

20. The device of claim 15, wherein:

the one or more motion drives include a planar motion drive; and

the device is fabricated using a layered wafer such that the planar motion drive is fabricated from a single layer of said wafer.

21. A MEMS device, comprising a motion drive supported on a substrate and having first and second movable portions, wherein, when a voltage differential is applied between the first and second portions, the first and second portions move with respect to the substrate and each other.

22. The device of claim 21, further comprising a spring structure having first and second flexible beams coupled between the substrate and a movable plate, wherein the motion drive is adapted to bend the flexible beams.

23. The device of claim 22, wherein:

the first movable portion is coupled to a non-end section of the first flexible beam; and

the second movable portion is coupled to a non-end section of the second flexible beam, wherein, when the non-end sections of the first and second flexible beams move in opposite directions substantially parallel to the substrate, the movable plate moves with respect to the substrate.

24. The device of claim 23, wherein, when the voltage differential is applied between the first and second portions, said non-end sections of the first and second flexible beams move in opposite directions by substantially equal distances and the movable plate translates toward or away from the substrate.

25. The device of claim 21, wherein:

the motion drive is a planar motion drive; and

the first and second movable portions are adapted to move substantially along a plane parallel to the substrate.

26. The device of claim 25, wherein the device is fabricated using a layered wafer and the motion drive is fabricated from a single layer of said wafer.

27. A method of operating a MEMS device, the method comprising:

changing the distance between first and second ends of a flexible beam from a prescribed distance, wherein:

the flexible beam is coupled at the first end to a substrate and at the second end to a movable plate positioned at an offset distance from the substrate, said first and second ends separated by the prescribed distance at a rest position; and

said change from the prescribed distance causes a change of the offset distance.

28. The method of claim 27, further comprising moving a non-end section of the flexible beam substantially along a plane parallel to the substrate, wherein the flexible beam is adapted to transfer said motion to the movable plate to change the offset distance.

29. A MEMS device, comprising:

flexible means for supporting a movable plate positioned at an offset distance from a substrate, said flexible means having a first end coupled to the substrate and a second end coupled to the movable plate; and

means for changing the distance between the first and second ends, wherein:

the first and second ends are separated by a prescribed distance at a rest position; and

change of the distance between the first and second ends from the prescribed distance causes a change of the offset distance.